



## Genetic diversity and response of gladiolus (*Gladiolus hybridus*) hybrids for growth, flowering and corms traits under ecological conditions of Delhi

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### ABSTRACT

The experiment was conducted with 22 hybrids and one check of *Gladiolus hybridus* at the research farm of the Division of Floriculture and Landscaping, Indian Agricultural Research Institute, New Delhi for three years from 2012-13 to 2014-15 to study their performance and genetic diversity under ecological conditions of Delhi for commercial traits. The mean performance (3 years) of gladiolus hybrids in terms of all vegetative and flower characters studied revealed and produced maximum plant height (133.33 cm), spike length (112.22 cm), diameter of flower (11.18 cm), width of tepal (5.33 cm), number of corms (3.55) and cormels/plant (85.11) by Pink Parassol Open seedling hybrid. Two hybrids namely P-16-1 × Eurovision and Melody Open seedling were found to be earliest and flowered in 75.44 and 75.66 days, respectively. One hybrid, i.e. AVE × Mayur had produced more number of florets/spike (21.10). Maximum length of tepal (7.41 cm), length of leaf (46.55 cm), width of leaf (3.94 cm), number of leaves/plant (7.22) were recorded in Melody Open seedling, P-16-1 × Eurovision, Salmon Queen Open seedling, Melody × Bindiya hybrids, respectively.

**Key words:** Gladiolus, Hybrids, Morphological diversity, Performance

Gladiolus (*Gladiolus hybridus*) is one of the most popular ornamental bulbous plants grown in many parts of the world for its cut flower and corm traits. It is commonly cultivated for garden display use, cut flowers, floral arrangements for table and interior decoration as well as for making high quality bouquets (Aswath and Parathasarathy 1996, Lepcha *et al.* 2007). The main emphasis in gladiolus improvement has been on development of varieties having attractive colour and large number of florets mainly for cut flower, long spikes, more number of well spaced large sized florets, and good corm multiplication ability. Gladiolus is very rich in varietal wealth and every year there is an addition of new varieties (Kumar and Yadav 2005). Multiplication of planting material of gladiolus is most important, because the cut flower trade of gladiolus is lagging behind over the recent years, owing to the unavailability of sufficient quality planting material at large scale (Barman *et al.* 2005). Moreover, new varieties also come from other countries and the performance of these varieties depends upon climatic conditions of the region under which they are grown. As a result, cultivars, which perform well in one

region, may not perform same in other regions of varying climatic conditions (Kamble *et al.* 2004). It is also important to develop Indian hybrids and evaluate them with the existing cultivar for their superior desirable characters (Archana *et al.* 2008). Hence, the present experiments were conducted to know the performance and morphological diversity amongst the newly developed hybrids for further commercial cultivation in northern plains.

### MATERIALS AND METHODS

The present experiments were carried out at the Research Farm of the Division of Floriculture and Landscaping, IARI, New Delhi for three years from 2012-13 to 2014-15 with 22 gladiolus hybrids along with one best check variety. Uniform corm size of each hybrid was planted during October in every year. The experiments were laid out in randomized block design with three replications, at a spacing of 45 × 15 cm at 6-8 cm depth in a plot size of 5.00 × 3.00 m. Irrigation was given immediately after planting. Plots were kept weed free by hand weeding. Adequate soil moisture was maintained in the soil by giving regular irrigation from time to time. Disease control measures were taken up by spraying fungicides such as Bavistin, Captan or M-45 whenever necessary, throughout the experiment to grow a healthy crop. Recommended dose of 120:80:80 kg/ha of NPK was applied. Nitrogen, phosphorus and potassium were applied in the form of urea, SSP and MOP, respectively. Other uniform agronomic practices were followed to all the

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treatment as and when required. Data for various vegetative, flowering and corms parameters were recorded at appropriate time after planting and analyzed by “analysis of variance” techniques as suggested by Panse and Sukhatme (1967).

## RESULTS AND DISCUSSION

Perusal of data presented in Table 1 reveals that different hybrids showed a significant difference between all the traits. Mean of three years data indicate the maximum plant height (133.33 cm) was recorded in Pink Parassol Open seedling hybrid followed by Melody × Bindiya (129.55 cm), Salmon Queen Open Veerangana (125.33 cm), Mayur × Green Willow (124.99 cm), Smokey Lady × Heady Wine (121.99 cm), Suchitra × Melody (121.66 cm). In contrast, the minimum plant height (88.33 cm and 90.64 cm) was recorded in High Hopes Open seedling and White Prosperity (check), respectively. This might be due to varied growth rate amongst the hybrids. Similar variations for plant height was also observed by Kalasaraddi (1996) and Shiramgond (1997), Sidhu and Arora (2000) in different gladiolus cultivars/hybrids. Among the different hybrids tested, P-16-1 × Eurovision hybrid was the earliest for days to first floret opening which opened first floret in 75.44 days followed by Melody Open seedling 75.66 days and (Berlew × Heady Wine) × (White Oak × Oscar) 79.88 days. Whereas, latest for first floret opening (108.55 day) was observed in hybrid Pink Parassol Open seedling. Ram *et al.* (2005) stated that days to flowering is controlled by genetic composition of cultivars, therefore, the differences in time taken for flowering can also be attributed to the genotype characters of hybrids under present study. Three years mean data also shows a wide variability and diversity amongst the hybrids for spike and rachis length (Table 2). The spike length is important characters for commercial value of gladiolus. Maximum spike length (112.22 cm) was obtained in hybrid Pink Parassol Open seedling followed by Mayur × Green Willow (110.77 cm), Suchitra × Melody (108.66 cm) and Salmon Queen Open seedling Veerangana (107.77 cm), whereas it was minimum (75.00 cm) in hybrid High Hopes Open seedling and check variety White Prosperity (78.10 cm). In case of rachis length, it was maximum (59.50 cm) in Melody Open seedling hybrid followed by Green Lilac Open seedling (57.66 cm), Smokey Lady × Heady Wine (56.88 cm) and P-16-1 × Eurovision (56.10 cm), whereas minimum rachis length (41.66 cm) was observed in White Oak × Flirt hybrid. The differences in spike length and rachis length can be attributed to the genetic constitution of the hybrids (Naresh *et al.* 2015). Variation for spike length and rachis length was also observed by Hegde (1996). Data enumerated in Table 3 reveals a significant diversity and difference for number of florets/spike and florets opened at a time amongst all the hybrids tested. More number of florets as 21.10, 20.44, 20.10, 18.88 and 18.66 were recorded in AVE × Mayur, Melody × Bindiya, Mayur × Green Willow, Little Fawn Open seedling and Suchitra × Melody hybrids, respectively. In contrast, minimum number of florets (14.66) was registered in White Oak × Flirt hybrid. With regard to the

florets opened at a time, more number of florets (7.11) were attained in Little Fawn Open seedling and Pink Parassol Open seedling hybrids whereas, it was seen minimum (5.44) florets in hybrid Berlew Open seedling. Further, three years mean data shows maximum length (6.77 cm) between first floret and second florets in hybrid Melody Open seedling followed by Salmon Queen Open seedling Veerangana (5.46 cm), whereas it was minimum (3.06 and 3.07 cm) in White Oak × Flirt and Suchitra × Melody hybrids, respectively (Table 4). With regard to the diameter of flower, the widest diameter of flower (11.18 cm) was noted in hybrid Pink Parassol Open seedling. In contrast, it was minimum (7.27 cm) in Cignet × RTS Hybrid.

An appraisal of data in Table 5 shows that due to various diversity in floral parameters, viz length and width of tepals reveals maximum length of tepals (7.41, 6.74, 6.65 and 6.62 cm) in hybrids such as Melody Open seedling, White Oak × Flirt, Salmon Queen Open seedling veerangana and Berlew Open seedling (Dark Orange) respectively. Amongst the various hybrids tested for different floral traits, hybrid Pink Parassol Open seedling resulted in maximum width of tepal (5.33 cm) followed by Salmon Queen Open seedling veerangana (5.23 cm) and Green Lilac Open seedling orange (5.21 cm). However, width of tepal was recorded minimum (3.35 cm) in Salmon Queen Open seedling surekha hybrid. It is apparent from Table 6 indicated that different diversity in hybrids influence the length and width of leaves significantly. The maximum length of leaf (46.55 cm) was registered in P-16-1 × Eurovision hybrid followed by hybrids Smokey Lady × Heady Wine (46.22 cm) and Mayur × Green Willow (46.00 cm). However, leaf length was recorded minimum (33.10 cm) in hybrid Salmon Queen Open seedling surekha. Moreover and very interestingly, the hybrids such as Little Fawn Open seedling, AVE × Mayur and Salmon Queen Open seedling veerangana had recorded equal length of leaf, i.e. (44.88 cm). Due to diversity in different hybrids, there had also a significant difference on width of leaf and it was maximum (3.94 cm) in hybrid Salmon Queen Open seedling veereangana. In contrast, leaf width was recorded minimum (2.08 cm) in hybrid High Hopes Open seedling. From the perusal of three year mean data, it was revealed that maximum number of leaves per plant (7.22) were recorded in Melody × Bindiya hybrid and minimum (6.11) in Berlew Open Seedling and (Melody × Mayur) × Heady Wine hybrids; whereas, three hybrids namely Smokey Lady × Heady Wine, Little Fawn Open seedling and Berlew Open (Dark Orange) had recorded equal number of leaves (6.88) per plant (Table 7). The protein and chlorophyll has paramount importance in physiological activities in plant, hence it increases the number of leaves. This finding is in accordance with Kumar and Misra (2011) in gladiolus.

In gladiolus, the number of spikes/plant depends on number of shoots/plant, which also decides the number of corms/plant (Shiramagondi and Hanamasthetti 1999). It is evident from Table 8 that hybrid Pink Parassol Open seedling had produced more number of corms (3.55) and cormels

Table 1 Plant height and days to first floret opening of newly developed gladiolus hybrids

| Hybrids                                 | Plant height (cm) |        |        |        | Days to first floret opening |        |        |        |
|---|-------------------|--------|--------|--------|------------------------------|--------|--------|--------|
|   | 2012              | 2013   | 2014   | Mean   | 2012                         | 2013   | 2014   | Mean   |
| Melody Open Seedling                    | 116.66            | 124.00 | 118.66 | 119.77 | 78.33                        | 73.33  | 75.33  | 75.66  |
| BL × HW × WO × Oscar (Pink)             | 125.33            | 116.66 | 120.00 | 120.66 | 75.00                        | 79.00  | 85.66  | 79.88  |
| Berlew Open Seedling (Light purple)     | 94.33             | 102.00 | 102.00 | 99.44  | 83.33                        | 92.33  | 94.66  | 90.11  |
| S. Lady × HW                            | 120.33            | 127.33 | 118.33 | 121.99 | 91.00                        | 95.00  | 102.66 | 96.22  |
| Little Fawn Open Seedling (Kataksha)    | 108.33            | 118.33 | 107.33 | 111.33 | 99.66                        | 102.00 | 104.66 | 102.10 |
| AVE × Mayur (Purple Pink)               | 109.00            | 112.33 | 110.66 | 110.66 | 82.00                        | 85.00  | 92.33  | 86.44  |
| Salmon Queen Open Seedling (Surekha)    | 89.33             | 89.00  | 97.00  | 91.77  | 99.33                        | 105.33 | 107.33 | 103.99 |
| Salmon Queen Open Seedling (Veerangana) | 120.33            | 124.66 | 131.00 | 125.33 | 88.33                        | 98.00  | 101.00 | 95.77  |
| RTS Open Seedling (Sinduri Red)         | 110.66            | 117.66 | 107.66 | 119.99 | 90.66                        | 94.00  | 96.33  | 93.66  |
| Melody × Mayur × Heady Wine             | 107.00            | 121.00 | 112.66 | 113.55 | 81.66                        | 89.00  | 99.33  | 89.99  |
| Green Lilac Open Seedling (Orange)      | 122.00            | 100.66 | 120.33 | 114.33 | 88.00                        | 93.00  | 94.66  | 91.88  |
| PinkParassol Open Seedling (Rajhans)    | 126.66            | 136.33 | 137.00 | 133.33 | 106.00                       | 108.00 | 111.66 | 108.55 |
| PB. × Lucky Shemrock                    | 118.33            | 111.33 | 118.00 | 115.88 | 104.66                       | 105.33 | 106.66 | 105.55 |
| S.Lady × Oscar (Red)                    | 88.33             | 104.66 | 108.33 | 100.44 | 88.66                        | 93.99  | 98.33  | 93.66  |
| P-16-1 × Eurovison                      | 117.66            | 102.66 | 129.00 | 116.44 | 69.66                        | 76.00  | 80.66  | 75.44  |
| Berlew Open Seedling (Dark Orange)      | 105.00            | 104.00 | 109.00 | 106.00 | 84.00                        | 89.00  | 91.66  | 88.22  |
| Mayur × Green Willow (Light pink)       | 123.33            | 130.66 | 121.00 | 124.99 | 91.66                        | 90.33  | 92.33  | 91.44  |
| White Oak × Flirt                       | 94.33             | 98.00  | 97.33  | 96.55  | 102.00                       | 103.00 | 101.66 | 102.22 |
| Cignet × RTS                            | 105.66            | 101.00 | 104.00 | 103.55 | 101.33                       | 100.00 | 102.00 | 101.11 |
| Suchitra × Melody (White)               | 118.00            | 112.00 | 135.00 | 121.66 | 104.00                       | 103.33 | 108.00 | 105.11 |
| High Hopes Open Seedling (White)        | 92.00             | 85.00  | 88.00  | 88.33  | 89.00                        | 88.33  | 91.00  | 89.44  |
| Melody × Bindiya                        | 131.33            | 128.33 | 129.00 | 129.55 | 90.00                        | 92.00  | 91.00  | 91.00  |
| White Prosperity (Check)                | 96.33             | 88.00  | 87.6   | 90.64  | 94.66                        | 92.33  | 92.66  | 93.21  |
| CD (P = 0.05)                           | 0.98              | 2.11   | 2.07   |        | 1.33                         | 1.86   | 1.36   |        |

Table 2 Spike and rachis length of newly developed gladiolus hybrids

| Hybrids                                 | Spike length (cm) |        |        |        | Rachis length (cm) |       |       |       |
|---|-------------------|--------|--------|--------|--------------------|-------|-------|-------|
|   | 2012              | 2013   | 2014   | Mean   | 2012               | 2013  | 2014  | Mean  |
| Melody Open Seedling                    | 98.33             | 114.00 | 103.00 | 105.11 | 58.66              | 64.86 | 55.00 | 59.50 |
| BL × HW × WO × Oscar (Pink)             | 107.33            | 94.33  | 109.66 | 103.77 | 60.00              | 52.66 | 53.33 | 55.33 |
| Berlew Open Seedling (Light purple)     | 80.00             | 87.00  | 92.00  | 86.33  | 44.00              | 42.00 | 45.33 | 43.77 |
| S. Lady × HW                            | 100.33            | 107.33 | 108.33 | 105.33 | 52.00              | 61.33 | 57.33 | 56.88 |
| Little Fawn Open Seedling(Kataksha)     | 92.66             | 95.66  | 96.00  | 94.77  | 52.66              | 53.33 | 46.33 | 50.77 |
| AVE × Mayur (Purple Pink)               | 91.66             | 97.66  | 94.66  | 94.66  | 61.66              | 53.33 | 52.66 | 55.87 |
| Salmon Queen Open Seedling (Surekha)    | 79.33             | 74.33  | 86.33  | 79.99  | 45.00              | 48.66 | 41.66 | 45.10 |
| Salmon Queen Open Seedling (Veerangana) | 100.33            | 101.66 | 121.33 | 107.77 | 48.66              | 58.00 | 45.33 | 50.66 |
| RTS Open Seedling (Sinduri Red)         | 94.66             | 100.33 | 97.66  | 97.33  | 55.33              | 33.33 | 51.33 | 46.66 |
| Melody × Mayur × Heady Wine             | 90.33             | 110.00 | 103.66 | 101.33 | 35.33              | 56.00 | 40.66 | 43.99 |
| Green Lilac Open Seedling               | 108.66            | 90.33  | 110.00 | 102.99 | 60.00              | 55.33 | 57.66 | 57.66 |
| Pink Parassol Open Seedling             | 100.33            | 118.00 | 118.33 | 112.22 | 46.00              | 55.00 | 57.00 | 52.66 |
| PB. × Lucky Shemrock                    | 100.00            | 95.00  | 108.66 | 101.22 | 48.66              | 50.66 | 47.33 | 48.88 |
| S.Lady × Oscar (Red)                    | 72.33             | 82.66  | 98.33  | 84.44  | 40.66              | 43.33 | 46.33 | 43.44 |
| P-16-1 × Eurovison                      | 98.33             | 88.66  | 119.33 | 102.10 | 57.33              | 48.33 | 62.66 | 56.10 |
| Berlew Open Seedling (Dark Orange)      | 86.66             | 88.00  | 98.66  | 91.10  | 40.33              | 51.66 | 53.66 | 48.55 |
| Mayur × Green Willow (Light pink)       | 110.66            | 108.66 | 113.00 | 110.77 | 48.00              | 46.00 | 57.66 | 50.55 |
| White Oak × Flirt                       | 76.66             | 87.33  | 86.00  | 83.33  | 41.66              | 41.33 | 42.00 | 41.66 |
| Cignet × RTS                            | 85.00             | 91.00  | 88.00  | 88.00  | 38.00              | 56.00 | 50.00 | 48.00 |
| Suchitra × Melody (White)               | 102.00            | 101.33 | 122.66 | 108.66 | 51.00              | 49.33 | 66.33 | 55.55 |
| High Hopes Open Seedling (White)        | 76.00             | 75.00  | 74.00  | 75.00  | 45.00              | 39.33 | 42.00 | 42.11 |
| Melody × Bindiya                        | 77.00             | 100.00 | 99.00  | 92.00  | 56.00              | 55.00 | 51.00 | 54.00 |
| White Prosperity ( C )                  | 86.00             | 82.66  | 65.66  | 78.10  | 55.00              | 45.66 | 45.00 | 48.55 |
| CD (P = 0.05)                           | 2.66              | 1.05   | 3.46   |        | 1.00               | 0.95  | 2.29  |       |

Table 3 Number of florets/spike and number of florets opened at the time of newly developed gladiolus hybrids

| Hybrids                                 | Number of florets/spike |       |       |       | Number of florets opened at a time |      |      |      |
|---|-------------------------|-------|-------|-------|------------------------------------|------|------|------|
|   | 2012                    | 2013  | 2014  | Mean  | 2012                               | 2013 | 2014 | Mean |
| Melody Open Seedling                    | 18.33                   | 19.00 | 17.00 | 18.11 | 6.00                               | 7.33 | 6.33 | 6.55 |
| BL × HW × WO × Oscar (Pink)             | 19.00                   | 16.66 | 17.33 | 17.66 | 6.33                               | 6.33 | 6.00 | 6.22 |
| Berlew Open Seedling (Light purple)     | 17.00                   | 15.66 | 16.00 | 16.22 | 6.66                               | 5.66 | 4.00 | 5.44 |
| S. Lady × HW                            | 18.00                   | 18.66 | 17.00 | 17.88 | 6.33                               | 6.66 | 6.33 | 6.44 |
| Little Fawn Open Seedling (Kataksha)    | 20.00                   | 18.66 | 18.00 | 18.88 | 8.00                               | 6.33 | 7.00 | 7.71 |
| AVE × Mayur (Purple Pink)               | 23.66                   | 19.33 | 20.33 | 21.10 | 7.00                               | 7.66 | 5.00 | 6.55 |
| Salmon Queen Open Seedling (Surekha)    | 17.00                   | 16.66 | 16.33 | 16.66 | 5.66                               | 6.33 | 5.66 | 5.88 |
| Salmon Queen Open Seedling (Veerangana) | 15.33                   | 17.33 | 14.33 | 15.66 | 6.00                               | 7.33 | 6.33 | 6.55 |
| RTS Open Seedling (Sinduri Red)         | 17.00                   | 17.66 | 17.00 | 17.22 | 7.00                               | 6.66 | 6.66 | 6.77 |
| Melody × Mayur × Heady Wine             | 15.33                   | 17.33 | 15.66 | 16.10 | 7.33                               | 5.66 | 7.33 | 6.77 |
| Green Lilac Open Seedling (Orange)      | 18.00                   | 18.66 | 17.33 | 17.99 | 5.00                               | 6.33 | 6.66 | 5.94 |
| Pink Parassol Open Seedling (Rajhans)   | 15.33                   | 16.66 | 17.00 | 16.33 | 7.00                               | 7.00 | 7.33 | 7.11 |
| PB. × Lucky Shemrock                    | 17.66                   | 17.66 | 18.00 | 17.77 | 6.66                               | 7.66 | 6.00 | 6.77 |
| S.Lady × Oscar (Red)                    | 15.66                   | 17.66 | 17.00 | 16.77 | 7.00                               | 6.33 | 6.66 | 6.66 |
| P-16-1 × Eurovison                      | 14.66                   | 15.66 | 15.66 | 15.32 | 5.66                               | 5.66 | 6.33 | 5.88 |
| Berlew Open Seedling (Dark Orange)      | 17.00                   | 19.00 | 18.33 | 18.11 | 5.00                               | 7.00 | 6.33 | 6.11 |
| Mayur × Green Willow (Light pink)       | 21.33                   | 18.33 | 20.66 | 20.10 | 6.33                               | 6.66 | 7.00 | 6.66 |
| White Oak × Flirt                       | 14.00                   | 15.00 | 15.00 | 14.66 | 6.33                               | 5.66 | 6.00 | 5.99 |
| Cignet × RTS                            | 18.66                   | 17.00 | 17.33 | 17.66 | 7.00                               | 5.00 | 6.66 | 6.22 |
| Suchitra × Melody (White)               | 18.33                   | 18.33 | 19.33 | 18.66 | 5.50                               | 5.00 | 6.66 | 5.72 |
| High Hopes Open Seedling (White)        | 15.33                   | 15.00 | 16.00 | 15.44 | 4.66                               | 6.00 | 6.33 | 5.66 |
| Melody × Bindiya                        | 21.00                   | 20.00 | 20.33 | 20.44 | 7.00                               | 6.60 | 6.56 | 6.72 |
| White Prosperity ( Check)               | 16.00                   | 15.33 | 15.66 | 15.66 | 6.33                               | 6.00 | 5.66 | 5.99 |
| CD (P = 0.05)                           | 1.03                    | 0.83  | 1.05  |       | 0.54                               | 0.56 | 0.99 |      |

Table 4 Length between first and second florets and diameter of flower of newly developed gladiolus hybrids

| Hybrids                                 | Length between first and second florets (cm) |      |      |      | Diameter of flower (cm) |       |       |       |
|---|--|------|------|------|-------------------------|-------|-------|-------|
|   | 2012   | 2013 | 2014 | Mean | 2012                    | 2013  | 2014  | Mean  |
| Melody Open Seedling                    | 5.66   | 7.66 | 7.00 | 6.77 | 9.50                    | 11.10 | 10.95 | 10.51 |
| BL × HW × WO × Oscar (Pink)             | 5.10   | 4.00 | 4.20 | 4.43 | 8.50                    | 8.00  | 8.66  | 8.38  |
| Berlew Open Seedling (Light purple)     | 4.86   | 4.00 | 4.00 | 4.28 | 9.00                    | 9.10  | 9.50  | 9.20  |
| S. Lady × HW                            | 3.60   | 5.50 | 4.10 | 4.40 | 8.88                    | 9.66  | 9.00  | 9.18  |
| Little Fawn Open Seedling(Kataksha)     | 4.33   | 4.53 | 4.30 | 4.38 | 8.65                    | 10.83 | 8.50  | 9.32  |
| AVE × Mayur(Purple Pink)                | 3.18   | 3.16 | 3.30 | 3.21 | 9.50                    | 9.16  | 9.33  | 9.33  |
| Salmon Queen Open Seedling (Surekha)    | 5.00   | 3.53 | 4.00 | 4.17 | 7.40                    | 9.83  | 7.66  | 8.29  |
| Salmon Queen Open Seedling (Veerangana) | 6.00   | 5.40 | 5.00 | 5.46 | 8.00                    | 12.33 | 10.00 | 10.11 |
| RTS Open Seedling (Sinduri Red)         | 4.00   | 3.50 | 3.60 | 3.70 | 9.50                    | 10.00 | 8.33  | 9.27  |
| Melody × Mayur × Heady Wine             | 5.33   | 5.83 | 5.00 | 5.38 | 9.00                    | 10.10 | 9.00  | 9.36  |
| Green Lilac Open Seedling (Orange)      | 5.66   | 5.53 | 5.10 | 5.43 | 9.70                    | 10.16 | 8.83  | 9.56  |
| Pink Parassol Open Seedling (Rajhans)   | 4.33   | 3.66 | 4.00 | 3.99 | 10.22                   | 11.66 | 11.66 | 11.18 |
| PB. × Lucky Shemrock                    | 3.66   | 3.50 | 3.40 | 3.52 | 9.11                    | 10.50 | 8.46  | 9.35  |
| S.Lady x Oscar (Red)                    | 5.00   | 3.53 | 3.20 | 3.91 | 9.00                    | 9.83  | 9.00  | 9.27  |
| P-16-1 × Eurovison                      | 7.00   | 5.83 | 6.00 | 6.27 | 9.22                    | 9.83  | 10.66 | 9.90  |
| Berlew Open Seedling (Dark Orange)      | 5.16   | 4.50 | 5.00 | 4.88 | 8.10                    | 9.66  | 7.50  | 8.42  |
| Mayur × Green Willow (Light pink)       | 3.30   | 3.23 | 3.00 | 3.17 | 7.66                    | 8.00  | 8.50  | 8.05  |
| White Oak × Flirt                       | 3.00   | 3.10 | 3.10 | 3.06 | 9.23                    | 6.00  | 7.50  | 7.57  |
| Cignet × RTS                            | 3.50   | 3.44 | 3.40 | 3.44 | 7.50                    | 7.00  | 7.33  | 7.27  |
| Suchitra × Melody (White)               | 3.00   | 3.12 | 3.10 | 3.07 | 7.50                    | 6.83  | 8.63  | 7.65  |
| High Hopes Open Seedling (White)        | 4.00   | 3.60 | 3.55 | 3.71 | 8.08                    | 9.00  | 9.00  | 8.69  |
| Melody × Bindiya                        | 5.66   | 5.00 | 5.10 | 5.25 | 11.00                   | 10.50 | 10.45 | 10.65 |
| White Prosperity ( Check)               | 4.66   | 3.53 | 4.00 | 4.06 | 8.55                    | 9.00  | 8.93  | 8.82  |
| CD (P = 0.05)                           | 0.45   | 0.33 | 0.36 |      | 0.66                    | 0.45  | 1.44  |       |

Table 5 Length and width of tepals of newly developed gladiolus hybrids

| Hybrids                                 | Length of tepals (cm) |      |      |      | Width of tepals (cm) |      |      |      |
|---|-----------------------|------|------|------|----------------------|------|------|------|
|   | 2012                  | 2013 | 2014 | Mean | 2012                 | 2013 | 2014 | Mean |
| Melody Open Seedling                    | 8.00                  | 6.90 | 7.33 | 7.41 | 4.56                 | 4.50 | 4.96 | 4.67 |
| BL × HW × WO × Oscar (Pink)             | 4.03                  | 5.00 | 5.00 | 4.67 | 3.80                 | 3.50 | 6.03 | 4.44 |
| Berlew Open Seedling (Light purple)     | 5.30                  | 6.00 | 5.33 | 5.54 | 4.33                 | 4.16 | 4.50 | 4.33 |
| S. Lady × HW                            | 6.00                  | 6.16 | 5.50 | 5.88 | 5.00                 | 4.53 | 5.00 | 4.84 |
| Little Fawn Open Seedling (Kataksha)    | 6.00                  | 5.00 | 5.33 | 5.44 | 4.33                 | 5.13 | 4.60 | 4.68 |
| AVE × Mayur (Purple Pink)               | 5.23                  | 5.16 | 5.03 | 5.14 | 3.90                 | 4.46 | 4.13 | 4.16 |
| Salmon Queen Open Seedling (Surekha)    | 5.00                  | 5.00 | 6.00 | 5.33 | 2.83                 | 3.63 | 3.60 | 3.35 |
| Salmon Queen Open Seedling (Veerangana) | 6.00                  | 6.96 | 7.00 | 6.65 | 4.66                 | 6.00 | 5.03 | 5.23 |
| RTS Open Seedling (Sinduri Red)         | 6.00                  | 7.00 | 6.00 | 6.33 | 4.00                 | 4.00 | 4.50 | 4.16 |
| Melody × Mayur × Heady Wine             | 5.80                  | 6.93 | 6.66 | 6.46 | 4.13                 | 4.53 | 4.30 | 4.32 |
| Green Lilac Open Seedling (Orange)      | 5.10                  | 6.50 | 6.66 | 6.08 | 5.36                 | 5.33 | 4.96 | 5.21 |
| PinkParassol Open Seedling (Rajhans)    | 6.00                  | 6.00 | 6.00 | 6.00 | 4.66                 | 5.50 | 5.83 | 5.33 |
| PB. × Lucky Shemrock                    | 5.50                  | 6.00 | 5.53 | 5.67 | 4.00                 | 5.00 | 5.00 | 4.66 |
| S.Lady × Oscar (Red)                    | 5.43                  | 7.00 | 6.00 | 6.14 | 4.03                 | 5.00 | 4.00 | 4.34 |
| P-16-1 × Eurovison                      | 6.00                  | 6.06 | 7.06 | 6.37 | 5.16                 | 5.00 | 4.86 | 5.00 |
| Berlew Open Seedling (Dark Orange)      | 4.80                  | 6.00 | 5.83 | 5.54 | 3.90                 | 4.16 | 4.16 | 4.07 |
| Mayur × Green Willow (Light pink)       | 6.33                  | 6.50 | 7.03 | 6.62 | 4.50                 | 4.60 | 5.00 | 4.70 |
| White Oak × Flirt                       | 6.33                  | 7.00 | 6.90 | 6.74 | 3.56                 | 4.00 | 4.00 | 3.85 |
| Cignet × RTS                            | 5.66                  | 5.00 | 5.40 | 5.35 | 4.00                 | 4.00 | 4.10 | 4.03 |
| Suchitra × Melody (White)               | 5.50                  | 5.43 | 6.00 | 5.64 | 4.50                 | 4.03 | 4.83 | 4.45 |
| High Hopes Open Seedling (White)        | 6.00                  | 6.00 | 6.10 | 6.03 | 4.16                 | 5.06 | 5.00 | 4.74 |
| Melody × Bindiya                        | 6.33                  | 6.00 | 6.15 | 6.16 | 4.83                 | 4.80 | 4.85 | 4.82 |
| White Prosperity ( Check)               | 6.00                  | 7.13 | 6.60 | 6.57 | 4.00                 | 3.20 | 3.16 | 3.45 |
| CD (P = 0.05)                           | 0.33                  | 0.53 | 0.55 |      | 0.48                 | 0.51 | 0.29 |      |

Table 6 Length and width of leaves of newly developed gladiolus hybrids

| Hybrids                                 | Length of leaf (cm) |       |       |       | Width of leaf at mid point (cm) |      |      |      |
|---|---------------------|-------|-------|-------|---------------------------------|------|------|------|
|   | 2012                | 2013  | 2014  | Mean  | 2012                            | 2013 | 2014 | Mean |
| Melody Open Seedling                    | 43.33               | 49.66 | 40.66 | 44.55 | 2.66                            | 2.86 | 3.50 | 3.00 |
| BL × HW × WO × Oscar (Pink)             | 40.33               | 39.66 | 41.33 | 40.44 | 3.56                            | 3.66 | 3.60 | 3.60 |
| Berlew Open Seedling (Light purple)     | 40.00               | 40.33 | 41.33 | 40.55 | 3.16                            | 2.98 | 3.00 | 3.04 |
| S. Lady × HW                            | 45.33               | 45.00 | 48.33 | 46.22 | 2.53                            | 2.53 | 2.06 | 2.37 |
| Little Fawn Open Seedling (Kataksha)    | 43.66               | 46.66 | 44.33 | 44.88 | 3.23                            | 3.66 | 3.96 | 3.61 |
| AVE × Mayur (Purple Pink)               | 45.33               | 46.00 | 43.33 | 44.88 | 3.90                            | 3.53 | 3.33 | 3.58 |
| Salmon Queen Open Seedling (Surekha)    | 35.66               | 30.33 | 33.33 | 33.10 | 2.06                            | 2.63 | 3.03 | 2.57 |
| Salmon Queen Open Seedling (Veerangana) | 45.00               | 45.33 | 44.33 | 44.88 | 4.00                            | 3.83 | 4.00 | 3.94 |
| RTS Open Seedling (Sinduri Red)         | 40.00               | 42.00 | 44.00 | 42.00 | 3.46                            | 3.93 | 3.00 | 3.46 |
| Melody × Mayur × Heady Wine             | 42.00               | 39.66 | 43.66 | 41.77 | 2.86                            | 2.53 | 3.06 | 2.81 |
| Green Lilac Open Seedling (Orange)      | 43.33               | 39.00 | 43.66 | 42.10 | 3.60                            | 3.66 | 3.50 | 3.58 |
| PinkParassol Open Seedling (Rajhans)    | 44.66               | 44.66 | 41.33 | 43.55 | 3.00                            | 3.53 | 3.53 | 3.35 |
| PB. × Lucky Shemrock                    | 38.33               | 38.66 | 44.00 | 40.33 | 2.53                            | 2.20 | 3.00 | 2.57 |
| S.Lady × Oscar (Red)                    | 32.00               | 36.00 | 46.00 | 38.00 | 3.03                            | 2.56 | 3.00 | 2.86 |
| P-16-1 × Eurovison                      | 50.00               | 48.00 | 41.66 | 46.55 | 2.50                            | 3.00 | 4.50 | 3.33 |
| Berlew Open Seedling (Dark Orange)      | 44.33               | 42.00 | 37.00 | 41.11 | 2.50                            | 2.46 | 2.50 | 2.48 |
| Mayur × Green Willow (Light pink)       | 40.00               | 52.00 | 46.00 | 46.00 | 2.33                            | 2.56 | 2.53 | 2.47 |
| White Oak × Flirt                       | 38.66               | 42.00 | 39.00 | 39.88 | 3.06                            | 2.90 | 2.80 | 2.92 |
| Cignet × RTS                            | 34.00               | 35.00 | 35.00 | 34.66 | 3.50                            | 4.00 | 3.20 | 3.56 |
| Suchitra × Melody (White)               | 39.00               | 36.33 | 44.66 | 39.99 | 3.30                            | 3.20 | 4.06 | 3.52 |
| High Hopes Open Seedling (White)        | 30.33               | 31.00 | 32.00 | 31.11 | 2.16                            | 2.00 | 2.10 | 2.08 |
| Melody × Bindiya                        | 41.0                | 40.00 | 39.50 | 40.16 | 3.93                            | 3.50 | 3.50 | 3.64 |
| White Prosperity ( Check)               | 36.33               | 35.33 | 35.66 | 35.77 | 3.53                            | 3.53 | 3.63 | 3.56 |
| CD (P = 0.05)                           | 2.11                | 0.95  | 1.49  |       | 0.28                            | 0.23 | 0.33 |      |

Table 7 Number of leaves/plant of newly developed gladiolus hybrids

| Hybrids                                 | Number of leaves |      |      |      |
|---|------------------|------|------|------|
|   | 2012             | 2013 | 2014 | Mean |
| Melody Open Seedling                    | 7.00             | 6.33 | 6.33 | 6.55 |
| BL × HW × WO × Oscar (Pink)             | 6.33             | 6.00 | 6.33 | 6.22 |
| Berlew Open Seedling (Light purple)     | 6.00             | 6.00 | 6.33 | 6.11 |
| S. Lady × HW                            | 6.00             | 7.66 | 7.00 | 6.88 |
| Little Fawn Open Seedling (Kataksha)    | 6.66             | 6.66 | 7.33 | 6.88 |
| AVE × Mayur (Purple Pink)               | 6.00             | 6.33 | 6.33 | 6.22 |
| Salmon Queen Open Seedling (Surekha)    | 6.00             | 6.33 | 6.66 | 6.33 |
| Salmon Queen Open Seedling (Veerangana) | 6.00             | 6.33 | 6.66 | 6.33 |
| RTS Open Seedling (Sinduri Red)         | 6.00             | 6.00 | 6.66 | 6.22 |
| Melody × Mayur × Heady Wine             | 6.00             | 6.00 | 6.33 | 6.11 |
| Green Lilac Open Seedling (Orange)      | 6.33             | 6.33 | 6.66 | 6.44 |
| Pink Parassol Open Seedling (Rajhans)   | 6.33             | 7.00 | 7.00 | 6.77 |
| PB. × Lucky Shemrock                    | 6.00             | 7.00 | 6.33 | 6.44 |
| S.Lady × Oscar (Red)                    | 6.00             | 6.66 | 7.00 | 6.55 |
| P-16-1 × Eurovison                      | 6.33             | 6.00 | 6.33 | 6.22 |
| Berlew Open Seedling (Dark Orange)      | 6.66             | 7.00 | 7.00 | 6.88 |
| Mayur × Green Willow (Light pink)       | 6.33             | 6.66 | 7.33 | 6.75 |
| White Oak × Flirt                       | 6.00             | 8.00 | 7.00 | 7.00 |
| Cignet × RTS                            | 6.66             | 6.00 | 6.00 | 6.22 |
| Suchitra × Melody (White)               | 6.00             | 7.00 | 6.66 | 6.55 |
| High Hopes Open Seedling (White)        | 6.00             | 7.00 | 6.00 | 6.33 |
| Melody × Bindiya                        | 7.66             | 7.00 | 7.00 | 7.22 |
| White Prosperity ( Check)               | 6.66             | 6.00 | 6.00 | 6.22 |
| CD (P = 0. 05)                          | NS               | 0.56 | 0.92 |      |

Table 8 Number of corms and cormels per plant of newly developed gladiolus hybrids

| Hybrids                                 | Number of corms per plant |      |      |      | Number of cormels per plant |       |       |       |
|---|---------------------------|------|------|------|-----------------------------|-------|-------|-------|
|   | 2012                      | 2013 | 2014 | Mean | 2012                        | 2013  | 2014  | Mean  |
| Melody Open Seedling                    | 3.00                      | 3.33 | 3.00 | 3.11 | 40.00                       | 21.33 | 25.00 | 28.77 |
| BL × HW × WO × Oscar (Pink)             | 2.00                      | 2.11 | 2.00 | 2.03 | 16.00                       | 17.00 | 16.66 | 16.55 |
| Berlew Open Seedling (Light purple)     | 2.00                      | 2.66 | 2.33 | 2.33 | 6.00                        | 21.00 | 18.66 | 15.22 |
| S. Lady × HW                            | 2.00                      | 3.00 | 2.00 | 2.33 | 64.00                       | 45.00 | 37.66 | 48.88 |
| Little Fawn Open Seedling(Kataksha)     | 3.00                      | 3.66 | 3.66 | 3.44 | 30.66                       | 31.00 | 37.00 | 32.88 |
| AVE × Mayur (Purple Pink)               | 2.11                      | 2.00 | 2.00 | 2.03 | 20.00                       | 18.00 | 17.00 | 18.33 |
| Salmon Queen Open Seedling (Surekha)    | 3.00                      | 3.00 | 2.66 | 2.88 | 18.00                       | 20.00 | 26.66 | 21.55 |
| Salmon Queen Open Seedling (Veerangana) | 2.66                      | 2.33 | 2.33 | 2.44 | 16.00                       | 18.00 | 19.33 | 17.77 |
| RTS Open Seedling (Sinduri Red)         | 2.33                      | 2.66 | 2.33 | 2.44 | 46.00                       | 54.00 | 42.00 | 47.33 |
| Melody × Mayur × Heady Wine             | 3.00                      | 2.66 | 3.00 | 2.88 | 44.33                       | 53.00 | 52.00 | 49.77 |
| Green Lilac Open Seedling (Orange)      | 2.66                      | 2.66 | 2.33 | 2.55 | 53.33                       | 80.00 | 75.00 | 69.44 |
| Pink Parassol Open Seedling (Rajhans)   | 3.00                      | 3.66 | 4.00 | 3.55 | 96.33                       | 76.00 | 83.00 | 85.11 |
| PB. × Lucky Shemrock                    | 2.00                      | 2.00 | 2.33 | 2.11 | 23.00                       | 23.33 | 22.00 | 22.77 |
| S.Lady × Oscar (Red)                    | 2.66                      | 3.00 | 3.00 | 2.88 | 33.00                       | 34.00 | 35.00 | 34.00 |
| P-16-1 × Eurovison                      | 3.00                      | 3.00 | 3.33 | 3.11 | 42.33                       | 39.66 | 37.00 | 39.66 |
| Berlew Open Seedling (Dark Orange)      | 2.66                      | 3.00 | 3.00 | 2.88 | 48.00                       | 30.33 | 45.00 | 41.11 |
| Mayur × Green Willow (Light pink)       | 2.00                      | 2.00 | 2.33 | 2.11 | 21.00                       | 20.33 | 19.66 | 20.33 |
| White Oak × Flirt                       | 3.00                      | 2.33 | 3.00 | 2.77 | 15.00                       | 15.66 | 13.00 | 14.55 |
| Cignet × RTS                            | 2.33                      | 2.00 | 2.33 | 2.22 | 24.00                       | 17.33 | 25.33 | 22.22 |
| Suchitra × Melody (White)               | 3.00                      | 2.66 | 3.00 | 2.88 | 27.00                       | 28.00 | 27.66 | 27.55 |
| High Hopes Open Seedling (White)        | 2.33                      | 2.33 | 2.00 | 2.22 | 20.00                       | 18.66 | 19.00 | 19.22 |
| Melody × Bindiya                        | 2.66                      | 2.66 | 2.33 | 2.55 | 20.00                       | 21.00 | 17.00 | 19.33 |
| White Prosperity ( Check)               | 1.33                      | 1.33 | 1.66 | 1.44 | 21.00                       | 20.00 | 19.33 | 20.11 |
| CD (P = 0.05)                           | 0.73                      | 0.46 | 0.97 |      | 3.33                        | 1.99  | 2.41  |       |

(85.11)/plant. The second best hybrid which produced corms/plant (3.44) was Little Fawn Open seedling. Hybrid Green Lilac Open seedling which recorded corms/plant (69.44). In contrast, minimum corms/plant (1.44) was recorded in check variety White Prosperity, whereas corms/plant (14.55) were recorded in White Oak × Flirt hybrid. Such variability in corm parameters might be attributed to influence of genetic makeup of varieties. Results are in line with the findings of Aswath and Parthasarthy (1996), Sheikh and Khanday (2008) and Balaram and Janakiram (2009). Sharma and Gupta (2003) reported that availability of more food material stored in bigger sized mother corms that helped in better plant growth might be associated with the beneficial effect and corms production depends on the size of corms. These findings confirm the results of present investigation. Analysis of variance revealed significant differences amongst all the morphological characters studied, indicating considerable amount of genetic diversity in gladiolus hybrids for their suitability for commercial cut flower and corms production traits.

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